Space Weather Technical Forecast

Issued on Tuesday, 15 November 2022 at 01:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (Minor to Moderate radio blackouts) throughout. Slight chance of S1 (Minor) Radiation Storms and X-class flares (Strong radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Low, but background flux is now up to C-class levels, with numerous mid-upper C-class flares, mainly from the largest region on the disc in the northwest (AR3140). AR3140 has shown continued strengthening of its intermediate spots through the day, with increasing magnetic complexity. Indeed, the intermediate spots have combined to a larger spot with a delta configuration in the past 12 hours. The region is now classified Ekc/Beta-gamma-delta and poses the most significant risk for further flares at this time. AR3141 (Eao/Beta) to the south of AR3140 has continued to slowly decay and appears simpler and smaller than at the start of the UTC day on 14 Nov. The remaining two regions, one in the northwest (east of AR3140) and the other in the northeast appear small and simple at present.

No significant Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, was indicative of waning high speed stream influences. Wind speeds were slightly elevated, varying, but on a declining trend between 420-480km/s. Density has been at average to below average levels. Total magnetic field strength (IMF) has been weak throughout, between 4-7 nT. The north-south component, Bz, has fluctuated weakly between +6/-5 nT. Phi angle has been largely negative (towards the Sun), but with some short-lived deviations into a positive (away from sun) sector, mainly at the start of the period. Geomagnetic activity was Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 has been at background to moderate levels, with a peak of 217 pfu at 14/2205 UTC. Electron fluence levels remained well below Active (1e8 integrated pfu) levels, with a generally very slight rising trend. Observed fluence at 15/0001 UTC was 4.93e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a chance of isolated M-class flares during the period. There is a slight chance of isolated X-Class flares, most likely from AR3140.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are likely to give significant impacts at Earth. Some minor CME effects are possible through this period, however any potential impacts would be expected to be weak. A very weak and slow CME may give very minor impacts on 18 or 19 Nov.

Solar winds are currently at slightly elevated levels due to waning coronal hole influences. Winds are expected to continue to slowly decline through much of, if not all of Day 1 (15 Nov). There are two small coronal holes which may give some enhancement later on Day 1, or from early on Day 2 (16 Nov). They may prolong the period of slightly elevated wind speeds into Day 3 or 4 (17 or 18 Nov), though confidence is low due to differences from the previous rotation.

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Geomagnetic activity is expected to be predominantly Quiet to Unsettled through the period. There is a chance of isolated Active intervals if we encounter any CIRs associated with the two coronal holes later on Day 1 or early Day 2, or if we see any weak CME related enhancements into the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is most likely to remain at background levels. However, there is a slight chance of an increase in solar radiation from AR3140 and AR3141 in the far western hemisphere. Electron flux is forecast to be at mainly background to moderate levels throughout the period. Fluence values are expected to remain below or well below the Active (1e8 integrated pfu) threshold throughout the period.

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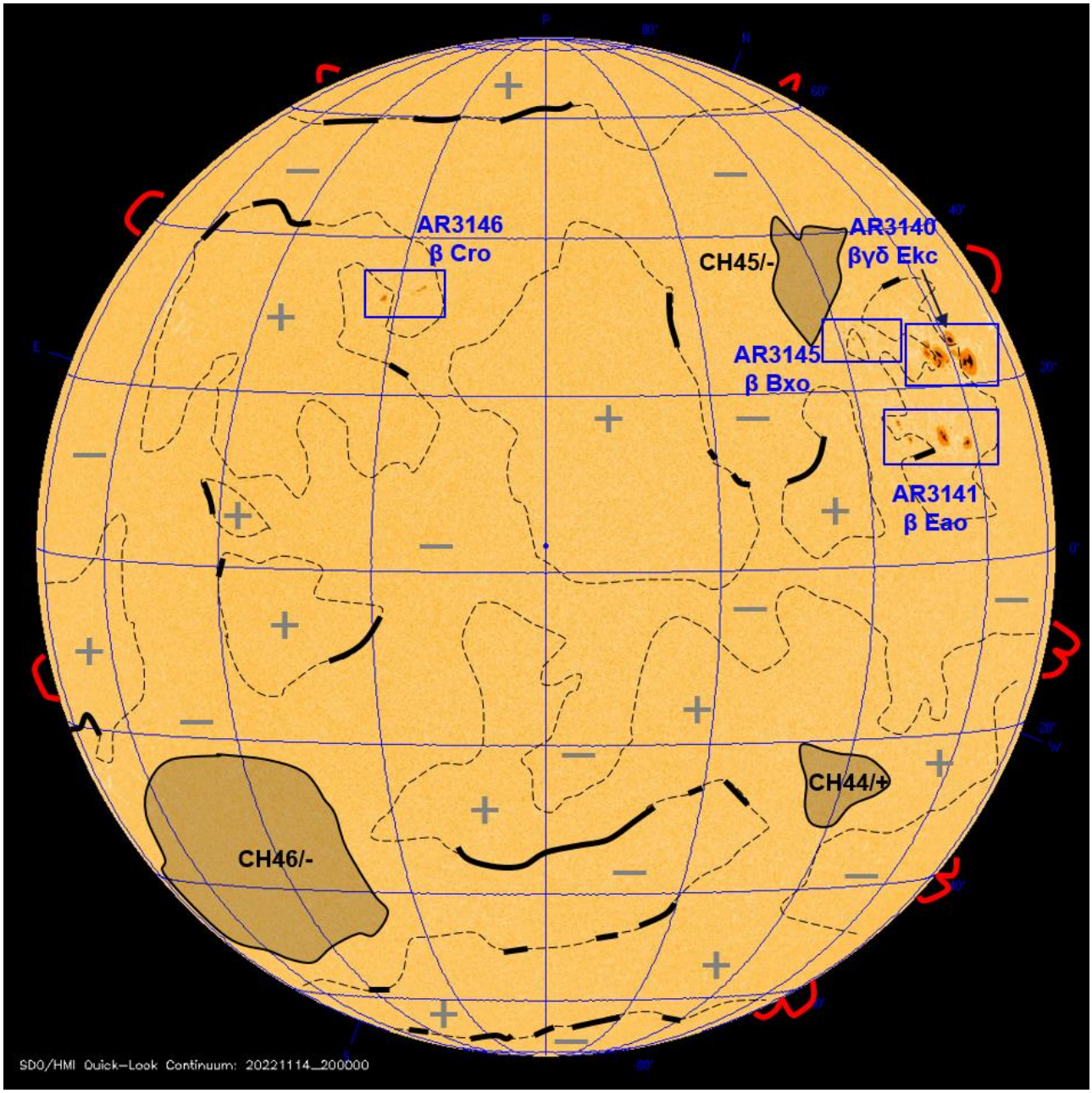
Figure 1. Solar Analysis Valid 14/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
No Earth-directed CMEs are likely to give significant impacts at Earth. Some faint ejecta from recent slow CMEs cannot completely be discounted as having some Earth directed component, however any potential impacts would be expected to be weak. A filament lift-off was observed from near south centre disc early on the 13 Nov, which gave a very weak and slow CME. This is expected to pass mostly below Earth's orbit on 18 or 19 Nov, and is unlikely to give significant impacts if it does give a glancing blow.

Solar winds are currently at slightly elevated levels due to ongoing, but waning coronal hole influences. Winds are expected to continue to slowly decline on Day 1 (15 Nov) as HSS effects wane. There are two coronal holes at a similar longitude on the disc: CH45/- in the north and CH44/+ in the south are both small, non-recurrent features. These are likely to give some enhancement either later into Day 1 or early Day 2 (16 Nov), although it is difficult to tell which of these features may become geoeffective at Earth as they are similar latitudinal distances away from Earth's position relative to the ecliptic. They may prolong the period of slightly elevated wind speeds into Day 3 or 4 (17 or 18 Nov), though confidence is low due to differences from the previous rotation.

STEREO-A may have encountered a CIR, perhaps linked to CH44/+ based on magnetometer data at around 14/2200 UTC. If confirmed, this could suggest that the same HSS starts to become geo-effective in the early hours of the 16 Nov (although as previously mentioned this carries low confidence).

Geomagnetic activity is expected to be predominantly Quiet to Unsettled through the period. There is a chance of isolated Active intervals if we encounter any CIRs associated with the two coronal holes later on Day 1 or early Day 2, or if we see any weak CME related enhancements into the period; this slightly more likely on Day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – None expected.

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Radio Blackouts - X-Ray Flares:

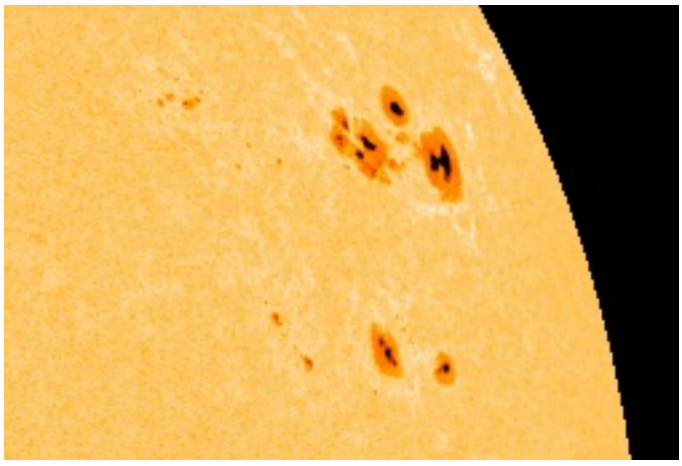
Solar activity is expected to remain Low to Moderate, with a chance of isolated M-class flares during the period. There is a slight chance of isolated X-flares most likely from AR3140.

There are four numbered regions on the visible disc. AR3140 (Ekc/Beta-gamma-delta) in the northwest continues to evolve and has shown sufficient development of its intermediate spots and magnetic complexity to suggest a gamma configuration to the magnetic polarity of the group. The modest delta spot in the region persists. AR3141 (Eao/Beta), also in the northwest remains generally stable with a more straightforward magnetic structure and slow decrease in size. AR3145 (Bxo/Beta), again in the northwest, continues with a fairly large longitudinal extent and minor growth, but no notable spots at this time. AR3146 (Cro/Beta) in the northeast remains a relatively simple region with a slight decrease in size.

AR3140 and AR3141 are expected to fully rotate off the visible disc on Day 3 (17 Nov) and Day 4 (18 Nov) respectively, although they will still pose some risk of flaring until they are well beyond the western limb. Two new bright regions of flux (evident on STEREO A EUVI 304 imagery) are, or will be rotating over the eastern limb in the southern hemisphere in the next 24-36 hours, although it is difficult to assess the likelihood of flaring from these until they become fully visible in available imagery. As such, the risk of flares has been kept flat through the four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 2: SDO HMI Intensitygram image of AR3140 (top right), AR3141 (lower right) and AR3145 (upper left), valid 15/0000 UTC. HMI Magnetogram imagery not currently available.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) at GEO, as observed by GOES-16, is currently at background levels and is most likely to remain at this level throughout the period. However, as AR3140 and AR3141 transit across the western solar hemisphere they give a slightly increased risk of proton storms over background conditions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux (greater than 2MeV) is currently at mostly background levels and is forecast to be at background to moderate levels through much of the period. The arrival of one or two weak HSS are probable either late Day 1 (15 Nov) or early Day 2 (16 Nov) from two small coronal holes, again significant charging is considered unlikely from either of these features. As such, moderate or perhaps briefly high electron flux is possible at the diurnal maxima from Day 2 onwards, but persistently high levels are considered unlikely, with reasonable confidence.

Electron fluence values are well below the Active (1e8 integrated pfu) threshold and are expected to remain so throughout the period, with a slight rising trend possible from Day 2 or Day 3 (17 Nov). The MOSWOC REFM currently supports electron fluence values remaining below the Active threshold on a slight rising trend. Fluence levels on the last rotation remained below the Active threshold and wind speeds were slightly higher last time around so a similar trend seems reasonable.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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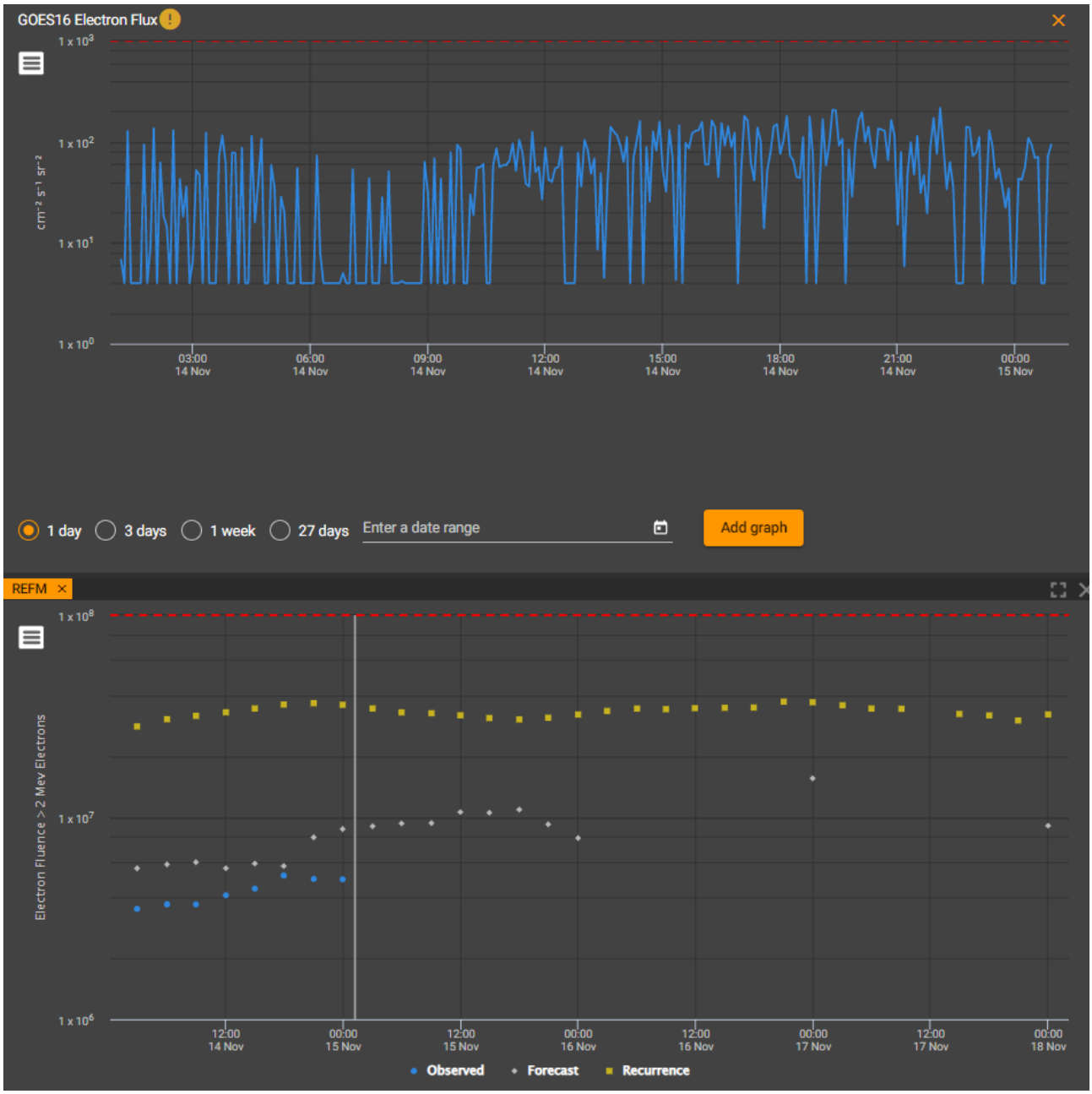
Figure 3: Latest GOES16 Electron Flux (top) and MOSWOC REF Model output (below)



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